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INVESTIGATION OF METEOROLOGICAL AND IONOSPHERIC CONDITIONS
OF THE OCCURRENCE OF NOCTILUCENT CLOUDS IN SIBERIA

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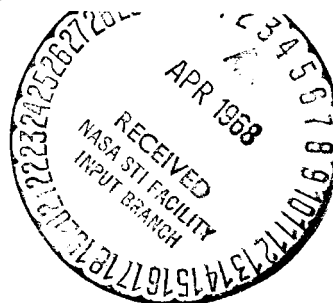
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INVESTIGATION OF METEOROLOGICAL AND IONOSPHERIC CONDITIONS OF THE OCCURRENCE OF NOCTILUCENT CLOUDS IN SIBERIA

N. N. Fast

ABSTRACT: The paper considers the question of the connection of noctilucent clouds with the synoptical conditions in the light of the conclusions [2-5]. The author could not draw any regularity in synoptical conditions prior to the noctilucent cloud appearance. The paper gives a statistical estimation of the hypothesis about the existence of the connection between the noctilucent cloud appearance and the height of the sporadic ionospheric layer E. There are no sufficient factual data to correct the hypothesis.

In 1963 the Commission on Meteorites and Cosmic Dust of the Siberian Section of the Academy of Sciences of the USSR organized on a public basis observations on noctilucent clouds in the city of Tomsk; they were carried out from May 15 to August 14. In 1964 the observations were expanded. Systematic monitoring and photographing of noctilucent clouds were carried out in Tomsk from May 5 to August 29, in Leninsk-Kuznetsk from May 25 to June 23, and in Zaimok-Kulika, in the Vanavara District of the Krasnoyarsk Territory, from July 17 to August 17. The following students and pupils of Tomsk higher educational institutions and schools made the observations: V. Baiez, I. Golubov, V. El'nikova, V. Zalevskaia, I. Ivanova, T. Koblova, M. Leshikhin, V. Lysykh, E. Olekhovich, V. Pankratov, V. Plekhova, G. Starkova, G. Filippov, V. Fast, etc. Twenty-nine cases of noctilucent clouds (including also doubtful ones) were recorded during the indicated periods of 1963 and 1964 in Tomsk. The time when the noctilucent clouds were observed, the characteristic of the twilight sector, the brightness and the forms of the clouds are given in a table, which includes also the data on noctilucent clouds recorded in Novosibirsk by observers of a station of young technicians (director S. S. Volnov). /106*

The earliest case of occurrence of noctilucent clouds was recorded from June 6 to 4, 1964 in Tomsk, and the latest from August 6 to 7, 1964 in Vanavara. The brightest clouds were observed from July 24 to 25, 1963 in Tomsk, from July 14 to 15, 1964 in Tomsk and from August 6 to 7, 1964 at Zaimok Kulika. Noctilucent clouds of longest duration amounting to 4 hours 30 minutes, were observed at Zaimok Kulika from August 1 to 2, 1963 and from July 30 to 31, 1964. Noctilucent clouds were not observed even once in Leninsk-Kuznetsk.

A relationship between the date of occurrence of noctilucent clouds and the moment of their detection was noticed by M. A. Dirikis [1]: in June noctilucent clouds occurred on the average up to midnight, but in the second half of summer, especially in August, after midnight. According to our data this indicated relationship did not appear. In Tomsk and Novosibirsk noctilucent clouds were observed principally after midnight; at Zaimok Kulika the clouds appeared always up to midnight, but their distinctive feature was a large horizontal extension: up to 150-160° in individual instances.

*Numbers in the margin indicate pagination in the foreign text.

Characteristics of Observed Noctilucent Clouds

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Station	Observation date	Time of observation		Observation of the two-light sector	Maximum brightness (tenths)	Forms of the clouds
		beginning	end			
Tomsk	1963 r.					
	14-15.VI	23 ^h 15 ^m	01 ^h 45 ^m	B-Γ	1-3	Streak, bands
	20-21.VI	01 39	03 00	B-B	2-4	" "
	22-23.VI	24 00	03 00	-	1-2	Bands (doubtful cases)
	1-2.VII	01 40	02 53	A	2	Streak
	8-9.VII	24 00	03 00	B	2	" bands
	15-16.VII	24 00	01 30	B	2	" "
	17-18.VII	23 55	02 35	A	3	" "
	19-20.VII	01 25	04 00	B	3	" "
	20-21.VII	00 35	04 00	A	4	Streak, bands, crests of a band doubtful cases
	21-22.VII	01 40	-	-	1	
	24-25.VII	00 15	04 00	B	5	Streak, bands crests
	28-29.VII	23 15	00 02	Γ-Δ	2	Bands, doubtful cases
Tomsk	1964 r.					
	08-9.VI	00 ^h 30 ^m	02 ^h 30 ^m	B-B	2	Streak, bands
	13-14.VI	01 20	03 45	A-B	3	" "
	15-16.VI	01 30	03 00	A	2	Streak, crests
	19-20.VI	00 15	03 18	A-B	4	Streak, bands, crests
	20-21.VI	11 30	00 15	Γ	3	Streak, bands
	23-24.VI	24 00	02 45	B-Γ	3	" "
	24-25.VI	01 00	02 45	B-Γ	1	" "
	26-27.VI	01 30	01 42	B	1	" "
	27-28.VI	12 40	01 20	A	1	" "
	28-29.VI	23 40	01 00	A	4	Bands, crests
Tomsk	1964 r.					
	3-4.VII	23 ^h 35 ^m	03 ^h 15 ^m	B	3	Streak, bands, crests
	8-9.VII	00 36	00 43	B	1	Bands, doubtful case
		01 30	03 00			
	9-10.VII	01 10	02 56	B	2	Streak, doubtful cases
	11-12.VII	24 00	-	Γ	1	The same
	12-13.VII	01 15	02 15	B-B	3	Crests, streak
		03 00	04 10			
	14-15.VII	24 00	01 00	B-A	5	All forms
Novosibirsk	1964 r.					
	13-14.VI	01 ^h 30 ^m	02 ^h 45 ^m	B-Γ	2	Streak, bands
	26-27.VI	12 45	01 00	B	3	Bands
	27-28.VI	01 00	01 22	A	1	" streak

Station	Observation date	Time of observation		Observation of the twilight sector	Maximum brightness (tenths)	Forms of the clouds
		beginning	end			
Novosibirsk	28 29.VI	23 ^h 30 ^m	02 ^h 15 ^m	B	4	Bands, streak
	3 4.VII	01 15	02 15	B	3	" "
	14 15.VII	24 00	03 45	B	4	Bands, vortices, crests
Vanavara	1963 r. 1-2.VII	22 ^h 30 ^m	03 ^h 00 ^m	A	4	Streak, bands, crests
	3-4.VII	23 30	03 00	A	4	All forms
Vanavara	1964 r. 30-31.VII	22 ^h 30 ^m	02 ^h 30 ^m	A	4	Streak, bands
	31-1.VIII	24 00	02 00	A	2	" "
	2-3.VIII	23 15	02 00	A	4	All forms
	6-7.VIII	23 45	02 15	A	5	" "

The Relationship of Noctilucent Clouds to Synoptic Conditions

N. I. Grishin [2-4] has noted that in the European part of the USSR, noctilucent clouds are observed usually during periods of intense increase in surface pressure. Also Ch. I. Villmann [5] points out the increase in surface atmospheric pressure at the point of observation before the appearance and during the presence of noctilucent clouds. According to our data, in 1963 an increase in surface pressure at the point of observation before the appearance of noctilucent clouds was recorded in 7 cases and a drop in pressure in 5 cases. An intense increase in pressure (5 mb in 24 hours) preceded noctilucent clouds only on June 14-15, but the brightest and richest diversity of cloud forms was on July 20-21 and 24-25. They were not preceded by an intense increase in pressure and in the second case a drop in pressure was even recorded. In 1964 noctilucent clouds in Tomsk and Novosibirsk were observed during low pressure: from 982 to 995 mb. In Tomsk 10 cases of noctilucent cloud observations out of 17 were accompanied by an increase in pressure; in Novosibirsk 4 cases were accompanied by a drop in pressure; and only two cases were preceded by a weak increase in pressure at the point of observation. Altogether, noctilucent clouds were accompanied by an increase in surface pressure at the points of observation in 59% of the cases; and a drop in pressure before the appearance of the clouds was rated in 41% of the cases.

We have analyzed the state of the twilight sector under different pressure formations at points of observation in order to discover favorable conditions for observation of noctilucent clouds. In addition, log books of noctilucent clouds monitoring and synoptic bulletins of the Central Forecasting Institute were used. Most frequently Tomsk found itself in the region of the warm sector of a cyclone and on the eastern side of an anticyclone; most rarely on the northern and southern sides of an anticyclone. The best conditions for detecting noctilucent clouds were those when the observation points were on the southern or western part of an anticyclone; conditions for their detection were poor in the near and warm sector of a cyclone and in the northern part of an anticyclone. Actually noctilucent clouds were recorded most frequently in the warm sector of a cyclone (5 cases) although within it conditions were good for their detection in only 25% of the cases.

Thus we still have not succeeded in discovering any regularities in the synoptic meteorological conditions preceding the observations of [noctilucent] clouds.

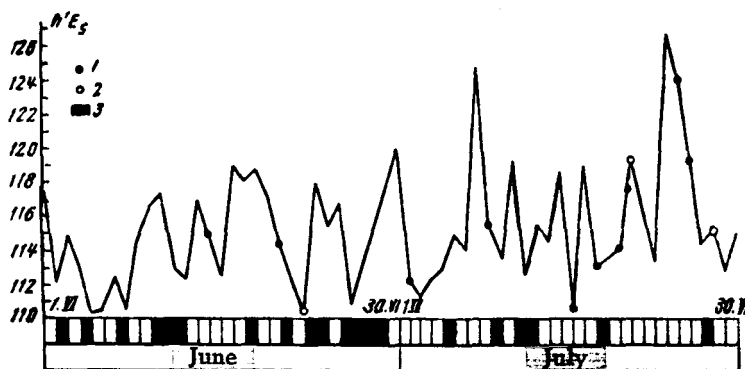
We have analyzed maps of temperature and pressure deviations from the normal in months preceding the maximum frequency of occurrence of noctilucent clouds. Thus July 1963, when a maximum of noctilucent clouds was recorded in Tomsk, was preceded by a warm June with a temperature up to 2° above normal over the entire territory of the West Siberian lowlands. The pressure over the entire West Siberian lowland exceeded the normal by 3.4 mb. /109

The maximum frequency of incidence of clouds in June 1964 was preceded by an abnormally large pressure deviation (up to 6 mb) in May, when also the temperature was above normal over the entire West Siberian lowland. In June 1964 temperature and pressure were below normal and correspondingly, clouds did not occur frequently in July.

The Relationship Between Noctilucent Clouds and the Ionosphere

The question of the relationship between noctilucent clouds and the state of the ionosphere has not been investigated. We made such an attempt in 1963. Cases of noctilucent cloud observations were compared with the state of the ionosphere according to a series of parameters. Mean daily values with their mean square deviations for all indices before and after the occurrence of noctilucent clouds were obtained. On the basis of the material for 1963 it was established that only the mean daily height of the sporadic $h'E_s$ layer can be implicated in the occurrence of noctilucent clouds [6]. As a rule noctilucent clouds were accompanied by a decrease in the mean daily height of the sporadic layer (see ill.). On the basis of the 1963 data above, we tested statistically the hypothesis that no relationship whatsoever exists between a decrease in $h'E_s$ and the occurrence of noctilucent clouds, i.e., the probability of a decrease in $h'E_s$ during the appearance of noctilucent clouds is equal to the probability of a decrease in $h'E_s$ in general (H_0 hypothesis). It appears that when all cases of occurrence of noctilucent clouds are taken into account, the probability of the hypothesis $H_0: P(H_0) = 0.013$, i.e., the H_0 hypothesis must be rejected; but when only authentic cases are considered, the same probability acquires the value $P(H_0) = 0.054$; hence the H_0 hypothesis cannot be rejected.

A similar calculation was made for June-July 1964 (Tomsk), June-August 1958 and May-August 1959 (Sverdlovsk). On the basis of a total analysis of all the material in our possession (46 observations of noctilucent clouds of which 7 are doubtful cases) it was found that the probability $P(H_0) = 0.18$ when all available reports on noctilucent clouds are considered and $P(H_0) = 0.14$ when only authentic cases are taken into account. This signifies that no basis exists for dismissing the H_0 hypothesis. /110



Variation of the Height of the Sporadic E_s Layer
During the Period of Observation
on Noctilucent Clouds

1. Presence of Noctilucent Clouds. 2. Doubtful Cases. 3. Obscuration of the Twilight Sector by Tropospheric Clouds (Cloudiness Greater Than 7 Tenths)

CONCLUSIONS

1. Noctilucent clouds are observed rather frequently in a series of points in Siberia. The seasonal maximum of their occurrence is in the second half of June - first half of July for Tomsk and Novosibirsk and at the end of July - beginning of August for Vana-
vara.

2. The meteorological situation accompanying the occurrence of clouds corresponds to some parameters established by N.I. Grishin for the European USSR (temperature and pressure in the month preceding the maximum number of occurrence of clouds, above the normal). However, another criterion of N.I. Grishin - occurrence of noctilucent clouds in the anterior part of an anticyclone is not confirmed.

About half of the cases of noctilucent clouds was observed during cyclone weather, since an intensive drop in pressure was recorded both before and after the occurrence of the clouds.

3. The most favorable conditions for observation of noctilucent clouds occur when the observation point is in the southern or western part of an anticyclone; the poorest conditions - when the observation points in the rear or warm sector of a cyclone.

4. Analysis of data of ionospheric soundings in the periods corresponding to observations on noctilucent clouds in Tomsk and Sverdlovsk shows that sometimes the time of occurrence of the clouds coincides with a decrease in the height of the sporadic layer and an increase in the frequency of E_s over 24 hours. We do not possess sufficient factual material confirming statistically this hypothesis.

Finally the author considers it his pleasant duty to state that this work was carried out under the direction of N. V. Vasil'yev with whom every stage of the work was discussed.

REFERENCES

1. M. A. Dirikis: Observations of noctilucent clouds in the Riga section of the All-Union Astronomical Geodesical Society, 1959. Proceedings of the Conference on Noctilucent Clouds. Tallin,
2. N. I. Grishin: The problem of the meteorological conditions of the occurrence of noctilucent clouds. Proceedings of the VI Conference on Noctilucent Clouds. Riga, 1961.
3. N. I. Grishin: Meteorological conditions of the occurrence of noctilucent clouds. Meteorology and Hydrology Bulletin, All-Union Astronomical Geodesical Society. 1963, No. 4.
4. N. I. Grishin: Wave motion and meteorological conditions of the occurrence of noctilucent clouds. Symposium "Some problems of meteorology," Press of the Academy of Sciences of the USSR.
5. Ch. Villmann: Observations of noctilucent clouds in Estonia in the summer of 1959. Proceedings of the VI Conference on noctilucent clouds. Riga, 1961.
6. N. V. Vasilyev, V. K. Zhuravlev, N. I. Zazdsavnykh, T. V. Prihod'ko, D. V. Demin, and L. I. Demina. On the relationship between noctilucent clouds and some atmospheric parameters. Proceedings of the Third Siberian Conference on Mathematics and Mechanics, 1964.

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